PIERIDAE.

Cepora Billberg	replaces	*Huphina* Moore
Valeria Horsfield	replaces	*Pareronia* Bingham
Eurema Hubner	replaces	*Terias* Swainson
Appias lyncida eleonora Boisduval	replaces	*Appias lyncida hippoides* M.

BAT MIGRATION IN INDIA AND OTHER NOTES ON BATS.

BY

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Some years ago (1940) my attention was drawn to a book *Ten Years Under the Earth* by Norbert Castaret in which there was a reference to bats migrating from France to Japan.

This was very unexpected and an inquiry put to Prof. Landsborough Thomson failed to elicit a confirmation. In his reply he stated that " there was at one time supposed to be evidence that bats crossed the Atlantic, but this was shown to be ill-founded ". He also referred to some notes on the subject in the *Journal of Mammology*, and some interesting information on the movements of Fruit Bats in Australia by Ratcliffe in the *Journal of Animal Ecology*, 1926, Vol. 1, p. 32. These papers, however, are not accessible to us.

In spite of the fact that there was no obvious evidence of bat migration similar to bird migration, all observers in India must have noticed that the smaller bats appear to come and go during different seasons. In 1942-43 when travelling was very restricted, we thought it would be a good idea to keep notes on the bat population in the caves of Elephanta Island in Bombay Harbour, and the writer with Messrs. Sálim Ali and Charles McCann made an attempt to do so. It was unfortunately impossible to keep notes over any length of time and no concrete evidence of migration is claimed, though they certainly indicate that extensive notes kept over a longer period would bring in valuable information.

As in birds, it was evident that the only method of individual identification was to ring them and we used a small aluminium bird-ring on the bat's forearm, the membrane being slit and the ring turned over the bone. All the males were ringed on the left wing; females on the right in order to facilitate observations.

Our attention was necessarily restricted to the bats inhabiting the several caves and dungeons and no tree-inhabiting bats were collected.

The fragmentary notes are summarised under each species.

The Fulvous Fruit Bat—*Rousettus leschenaulti* (Desm.)

This was the most numerous species, and was seen at some time or the other in all the caves, though the larger number was usually in the " Dungeon Cave " at the western end of the cave-hill. The entrance has fallen in and the floor has also silted up to some extent. The average visitor does not approach or enter this cave.

On 11 April, 1942, the fruit-bats were plentiful and roughly estimated at about a thousand. Many had young clinging to them. When

first approached they squealed in chorus, with intervals of complete silence. On further molestation, they flew out of the cave and hung on the rocks and trees outside. This was at about 6 p. m., but Pariah Kites were attracted and two bats were seen to be captured on the wing. In the excitement, several young fell off their mothers in the cave.

On 10 May most of the young were independent, and we made our first attempt at ringing. Of 43 bats captured (with a large butterfly net) 26 were males and 17 females (as against 9 males and 21 females on 14 June). The sex ratio over the total number examined was 35 males to 38 females (52 per cent). Of 16 juveniles included, 11 were females (69 per cent).

On 26 July, they were still abundant, but on 29 November this Dungeon Cave was deserted except for 5 or 10 individuals. There is definite indication that they had left the locality in late November.

On 10 January, 1943, their numbers had increased to some extent. On 28 March 150-200 bats were back, the females being pregnant or with new-born young. Hundreds were back again on 8 October, 1944.

At Kihim, across the Harbour, about 16 miles from the caves, on 13 May, 1943, my brother Shamoon picked up one of the bats ringed by us on 28 March, struggling on the ground, covered by ants and with a festering wound near the ring.

In the cave harbouring these fruit bats, there was in the right-hand corner a hole running into the earth at an angle of 45 degrees or more. A quill outside suggested a porcupine and an attempt to investigate the hole further was discouraged by a rumbling noise from within. Small numbers of two small bats, *H. fulvus* and *R. rouxi*, were occasionally noted in this cave, but in separate corners and far from *Rousettus*.

Tenebrionid beetles were abundant on the walls and on the floor under the bats, presumably being associated with the bats' droppings.

A Chrysomelid beetle, *Aulacophora* sp., formed small clusters on the walls, in this and other caves. The large gecko (*Hemidactylus maculatus*) was seen in this cave as also a monitor lizard (*Varanus*) at the entrance.

Mr. McCann has more detailed notes on the biology of this bat on Salsette Island, *J.B.N.H.S.* 41, pp. 805-816. Brother Novarro of St. Xavier's High School informs me that there are several large colonies of this species in the tunnels on the disused railway line just below Khandala. These tunnels are deserted about the end of June (depending upon the incidence of the monsoon) and the bats return early in December.

The Bicolored Leaf-nosed Bat—*Hipposideros fulvus* (Gray.)

On 11 April, this and the next form were thinly scattered all through the series of caves, but formed largish colonies in the two small caves on either side of the main cave. (These will be referred to as the Right and Left cave.) Here also they appeared to form independent colonies, this species being more numerous in the Left cave though a few were captured in the Right. The next species appeared to be more restricted to the Right cave. 39 were ringed of

which 28 (71 per cent) were females, many being heavily pregnant. Six secured in the Dungeon Cave were all females.

On 14 June, many females were carrying new-born young. On 25–26 June, both this and the next species were scarcer and on 29 November, as in the fruit bat, their numbers had dwindled to a few individuals.

The Horse-shoe Bat—*Rhinolophus rouxi* (Temm.)

As stated above, this was common in the Right cave on 11 April and was not seen on the 10 May when both the small caves were in the possession of the previous species. On 13 and 14 June, they had regained their numbers in the Right cave, several juveniles and newly-born young being noted. Later, their numbers decreased in the same way as for other species.

Of 11 ringed on 14th June, 9 were sexed and included six females (66 per cent).

The Indian Vampire Bat—*Megaderma lyra* (Geoff.)

This was first noted on 25 July when 5 or six were seen in the Left cave with a greater diminuation in the numbers of both the small bats. Had the monsoon driven it in and was its presence responsible for the departure of the smaller bats? Below their perches, we picked up the wings of two species of Noctuid moths, *Ophiderus fullonica* L. and *Ophiusa coronata* F. which had been taken by this bat in some numbers. Both these moths have the hind-wings brightly colored (black and yellow). No remains of plain coloured moths were seen.

Solos of this bat were noted on 25 October and 29 November, though none were seen on 10 January.

The Long-armed Sheath-tailed Bat—*Taphozous longimanus* (Hardw.)

This can immediately be identified in the field as it clings to the vertical wall rather than the ceiling as do the other bats. Three or four were seen on almost every trip, but were solitary and seemed to live happiest apart. They were more frequently in the small lingam cave adjoining the rock-pool from which water is drawn. Curiously, the five individuals ringed on 9 May and 13 June were all males, and in spite of the scarcity of their numbers, none seen there again on the 10 January carried a ring.

The Bearded Bat—*Taphozous melanopogon*, of which there is a large colony at the Kaneri Caves in Salsette Island was not observed at Elephanta.

After the above notes were compiled, I noticed a very interesting article in the July 1946 issue of the National Geographic Magazine entitled 'Mystery Mammals of the Twilight' by Donald R. Griffin of Harvard University. In view of the very limited information in India and the unavailability of literature, I have been tempted to pick out the highlights of this article as it may be a very long time before we are able to bring together similar information concerning Indian species. The following is almost a verbatim extract from the article.

Most of the bats in the United States belong to the family Vespertilionidae which feed exclusively on insects. Those living in the Northern States therefore find themselves without food in winter. This difficulty is overcome by one of two methods—Hibernation or Migration. As a general rule, cave bats hibernate while those that live outside migrate. The North American Red Bat, *Lasiurus borealis*, is reported to appear in Bermuda in autumn and disappear again at other seasons. If this is true, it must make a sustained flight of more than 600 miles over the open ocean.

In Germany, Dr. M. Eisentraut, banded several thousand bats and recaptured many of them later. One, *Nyctalus noctula*, was recaptured nearly 500 miles from where it was banded and several others were recorded after they had travelled more than 100 miles.

Mr. Griffin banded the bats on the hind legs with an aluminium bird band of the smallest size and some of his bats have been recovered 150 to 170 miles from the caves where they were banded in winter.

There is reference to a very positive homing instinct in bats, 30-40 per cent of those banded in a given cave being retaken in the same place the following winter. Bats transported over distances upto 150 miles also found their way back with comparative ease. 24 were released out at sea 12 miles from the nearest island and 35 miles from their home roost. Six of these or 25 per cent were later retaken at the building where they were banded.

It is also noted that bats from large caveless areas have to migrate to limestone areas to enable them to hibernate.

Another very interesting part of the article explains the remarkable and inexplicable manner in which the bats have always been known to avoid obstacles in the dark. As far back as the 18th century, the Italian scientist, Lazaro Spallanzani wrote that bats which had been blinded flew about the room avoiding walls, furniture and silk threads stretched in their path. His friend, Louis Jurine, repeated these experiments and made the additional discovery that bats lost their ability to avoid obstacles when their hearing was impaired. This observation was again confirmed by Spallanzani, but the celebrated anatomist, Georges Cuvier expressed his incredulity in the quip 'Since bats see with their ears, do they hear with their eyes?' So convincing were a great man's words that Jurine's discovery was completely forgotten until the present century, when Dr. Robert Galambos and Mr. Griffin, by holding a bat before an electronic apparatus for detecting supersonic sounds (sounds of a pitch higher than what the human ear can hear) found it actually making loud supersonic cries. Their later experiments showed that the echoes of these cries enabled the bats to detect obstacles in their flight and dodge in time to avoid collision. This has been established as the chief mode of perception available to bats and is so distinct from other types of perceptions that a new word 'echolocation' has been coined to represent its meaning. This can be so exact, that even when blind-folded they can fly between vertical 16-gauge wires spaced 12" apart, brushing the wires only once in 6 to 10 passages. They do this while flying at full speed, 'echo-locating' the wires when a foot or two away, and banking or pulling in their wings to pass between them.

The process of 'echo-location' is not confined to bats, and many totally blind persons acquire an uncanny ability to move about with-

out striking furniture, walls or other obstacles. Most of them have no clear idea how they do this. Three psychologists at Cornell University have shown that they lose this ability if their ears are stopped.

In foggy, coastal waters fishing and steamboat captains can detect the presence of cliffs or rocks by blowing a short blast with the ship's whistle and listening for echoes. Another example is the sonic depth-finder or the fathometer which sends down sound waves through the water and measures its depth by the time interval between each sound and its echo.

The modern miracle of Radar is analogous to this process, but different in so far as Radar employs radio waves while bats use sound waves.[1]

While talking of bats, it might be interesting to record that E. C. Humphries and T. S. Jones in an interesting article on bat-hunting in Trinidad published in the *Field* dated 19 January, 1946, state that the Vampire Bat is 'the carrier of paralytic rabies—a dread human disease'. This bat is also known to transmit Murrina, a trypanosome disease of cattle, a factor of some economic importance in many parts of South America.

They also say, 'One of the most interesting Trinidad bats is the Fisherman Bat observed and described as long ago as 1871 by Charles Kingsley in "At Last". It may be seen at dusk, skimming over the sea, occasionally darting to the surface to pick up a fish. Owing to the difficulty of observing this bat at close quarters, together with the poor light at the time they were active, there is still some controversy about the exact method of catching their prey. The current opinion is that the interfemoral membrane (the membrane between the hind legs) scoops downwards as the bat approaches the water and acts as a brake to its motion. It was formerly thought that the interfemoral membrane acts as a scoop to pick up the fish, but the prey is probably lifted out of the water by the claws of the hind feet which are large and apparently well adapted to this purpose. These bats live in colonies, usually in sea caves but they have also been found in hollow trees and under houses. Their presence is usually quickly detected by the unforgettable stench which is a mixture of bat odour and decaying fish!'

It might be interesting to recall that there has been some discussion in India regarding the fishing propensities of the Flying Fox which is known to skim over water. McCann in his notes on the Flying Fox, (*J.B.N.H.S.* 37, pp. 146) discredits this habit, and though we have seen bats do this on both fresh and salt water we agree with him. Dr. E. W. Gudger in Fish-eating Bats of India and Burma (*J.B.N.H.S.* 43, pp. 635-40) has gone into the question in detail and it appears that in our area, only the Vampire Bat, *Magaderma lyra*, has been known to eat fish, small pieces being found under their roosts. How the fish are caught is unknown, but a considerable number of frogs are also said to be taken by this species.

Bats are abundant in India and of many kinds, but so little is known of their habits that any information which members may be able to offer from their own experience would be of considerable value.

[1] For more details see 'Bat Radar' by Richard H. Knight (The New Biology, 1947—Pelican Books).